KU LEUVEN

Methodology for assessment of the rat jaw bone microstructure using ex-vivo micro-computed tomography

M. Chatterjee[1], F. Faot[1,2], C. Correa[1,3], J. Duyck[1], I. Naert[1], K. Vandamme[1]

[1]KU Leuven & University Hospitals Leuven - Department of Oral Health Sciences & Dental Clinic, Leuven, Belgium;
[2]Federal University of Pelotas - School of Dentistry, Pelotas, Brazil; [3]University of Campinas - UNICAMP/ Piracicaba Dental School, Piracicaba, Brazil

Objectives

Micro-computed tomography (microCT) can be applied in the maxillofacial bone region for assessment of the micro-architectural characteristics of the cortical and trabecular bone, alveolar bone (re)modelling, etc in either physiological or disease conditions. However, **reports often lack a detailed description of the methodological steps used to analyse the microCT images**, such as the considered regions of interest (ROIs), the algorithms used for image filtration and the approach used for image segmentation and the bone parameters quantified, thereby making it difficult to compare or reproduce the studies. **This study addresses this critical need and aims to provide standardized assessment and consistent parameter reporting related to jaw bone image analysis**. The proposed methodology is applied to the rat jaw bone for supplying proof-of-concept.

Material & Methods

Various regions of the rat jaw bones from 3 different hormonal conditions were screened for its potential for standardized microCT analysis (Fig 1). Furthermore, the ROIs that were anticipated to be most susceptible to bone structural changes in response to experimental interventions were defined. In the mandible, two ROIs were selected, namely the condyle (Fig 2A) and the alveolar bone surrounding the 3 molars (Fig 2B,C); In the maxilla, the maxillary tuber region (Fig 3A) and the intra-radicular septum of the second molar (Fig 3B,C).

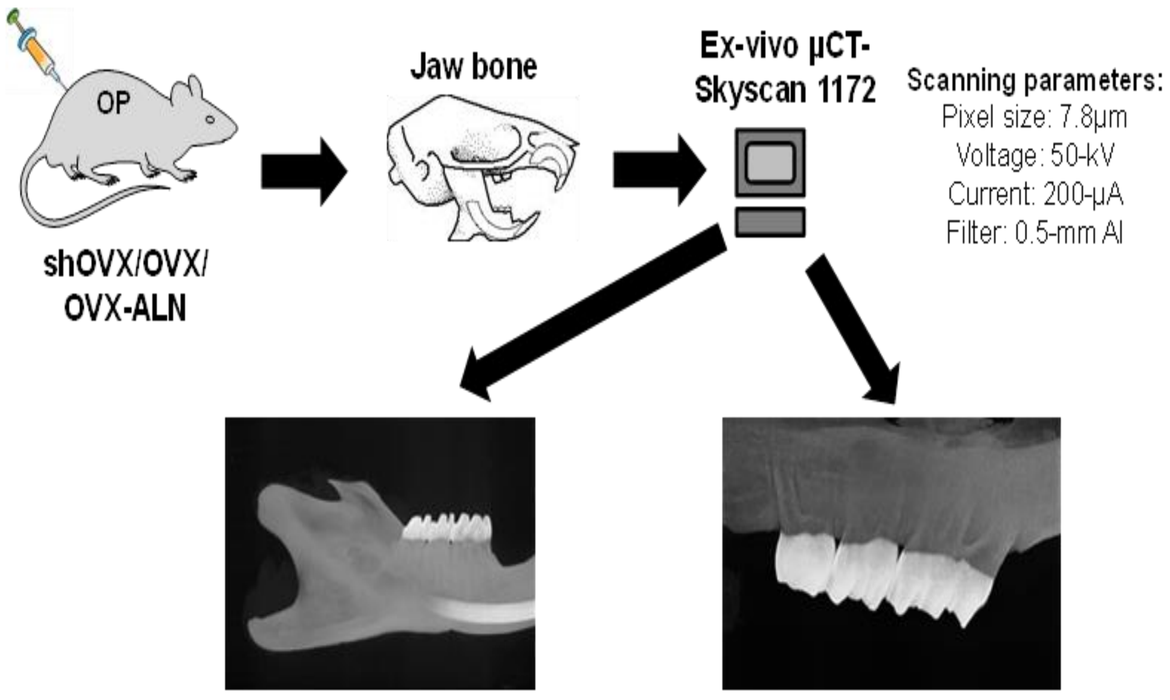

Fig.1 The experimental sequence leading to the analysis of the rodent jaw bone using micro-CT. Bottom left: micro-CT image of rodent mandible. Bottom right: micro-CT image of rodent maxilla.
OP: Osteoporosis, OVX: Ovariectomy-induced osteoporosis, shOVX: sham; OVX and ALN: alendronate-treated OVX animal.

Results

The procedures for manual and automatic (ellipsoid/rectangle) delineation of the different ROIs, based on well-defined landmarks are illustrated in Fig 2 and Fig 3. The developed microCT protocol was applied for analyzing the jaw bone micro-architecture of osteoporotic rats, either untreated or treated with bisphosphonates (ongoing study).

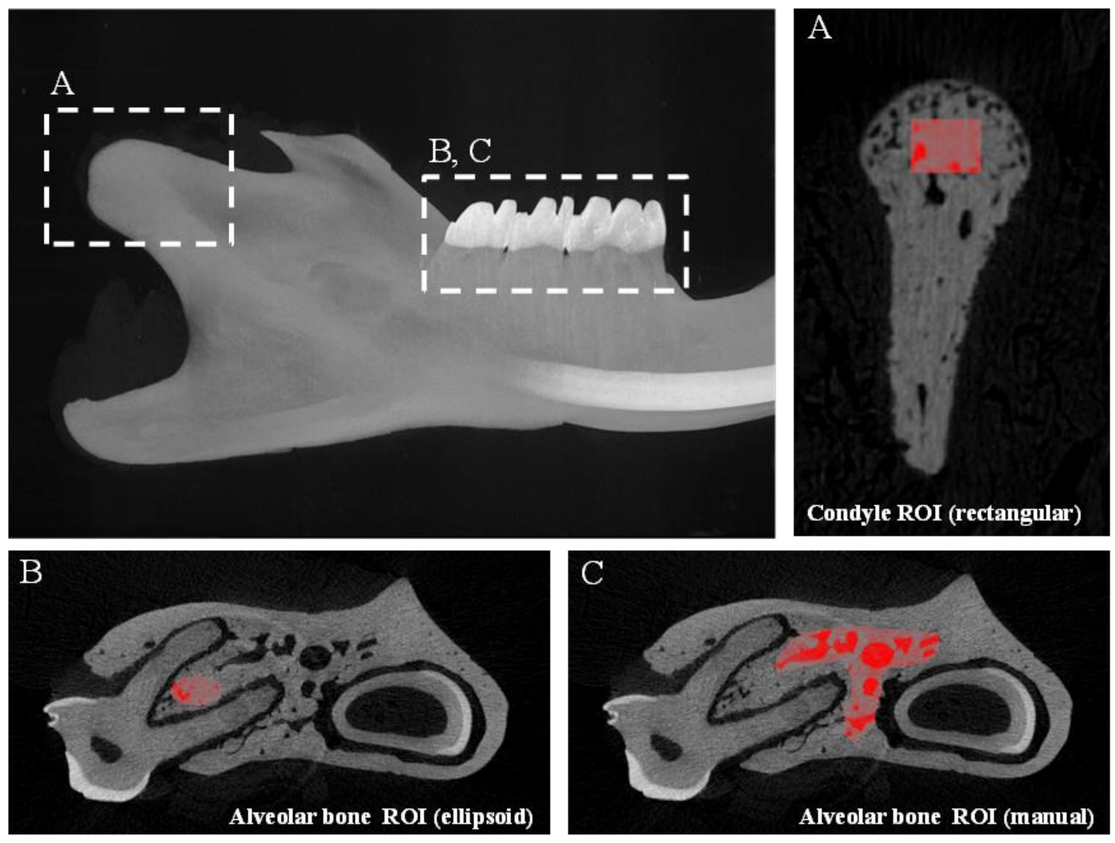

Fig.2 Micro-CT image of the rat mandible showing the selected ROIs. A) Condyle (rectangular-shaped ROI); B) Alveolar bone of M2 (standard ellipsoid-shaped ROI); C) Alveolar bone of M2 (manually drawn ROI delineating the trabecular bone).

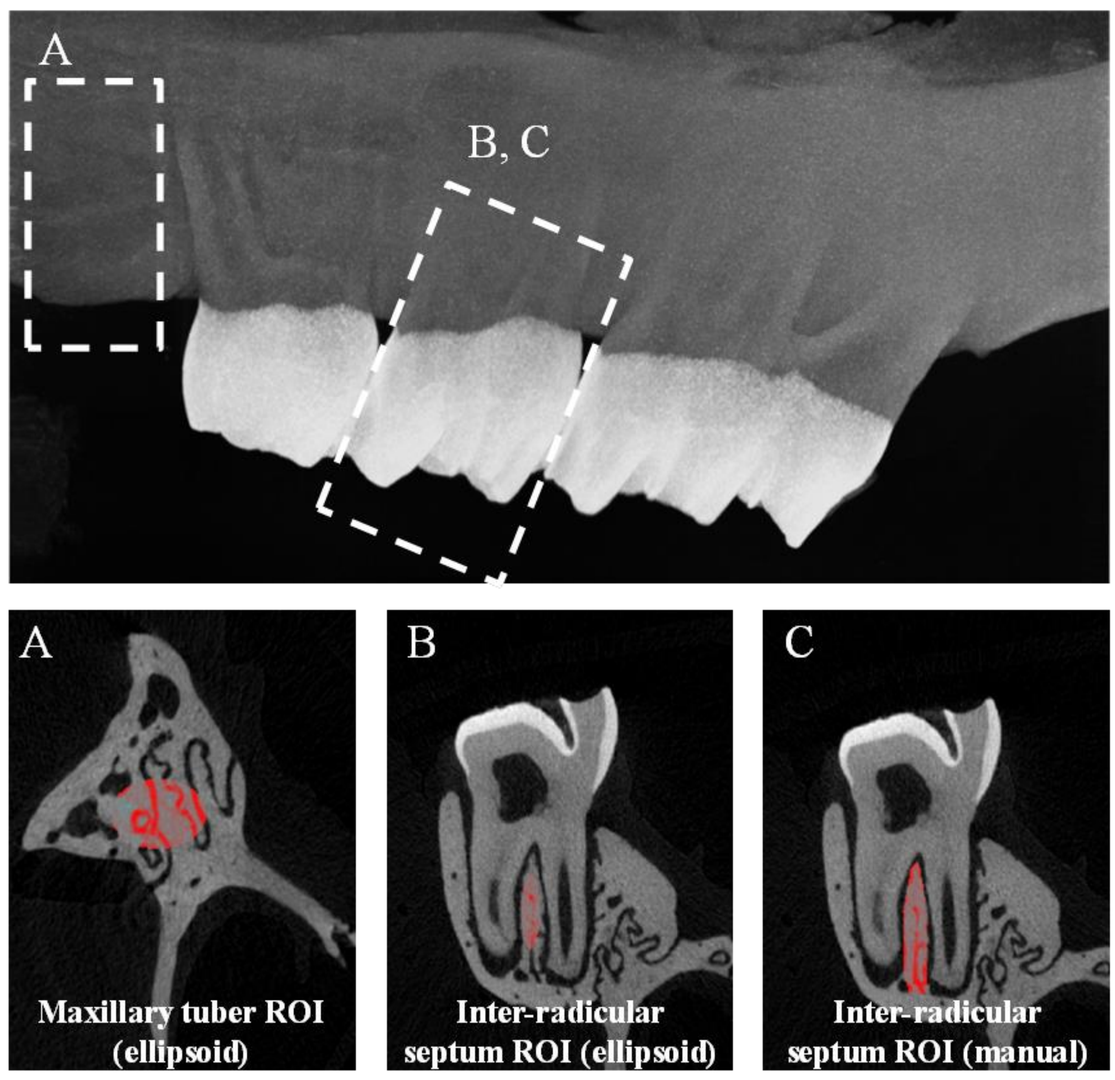

Fig.3 Micro-CT of the rat maxilla showing the selected ROIs. A) Tuber (ellipsoid-shaped ROI); B) Inter-radicular septum of M2 (standard ellipsoid-shaped ROI); C) Inter-radicular septum of M2 (manually drawn ROI delineating the trabecular bone).

Conclusion

The protocol developed in **this work provides a standardized and reproducible methodology for microCT analysis of relevant jaw bone ROIs,** and is intended to ensure global, accurate and consistent reporting of microCT-derived jaw bone morphometry. Furthermore, the proposed methodology holds potential as a variety of rodent animal models would benefit from its implementation.

Acknowledgements

This work was supported by FWO Vlaanderen (G.0726.09), the Brazilian Science Without Borders Programme (245450/2012-2 process, Postdoctoral researcher F. Faot) and Fundacao de Amparo Pesquisa do Estado Programme (2014/0892-1 process, Postdoctoral researcher C. Correa).

KU Leuven biomat